

## THE SYSTEMATIC VALUE OF THE MALE GENITALIA OF DELPHACIDÆ (HOMOPTERA).

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During the past three years the writer has had an exceptional opportunity to study the male pygofer and genital organs of large collections of Delphacidae, including many types and paratypes, representing most of the species described from North America and the West Indies. Because of their constancy and reliability as a specific character these organs (which of course include the aedeagus or penis) are unquestionably of first importance to the student in making correct determinations. The use of color as a specific character has led to synonymy on account of there sometimes being four color forms in a species, the sexes of both the brachypterous and macropterous forms being different. And among these forms there is often considerable color variation. This naturally results in much perplexity to the student of these insects.

There have been and there are still strong objections by some workers (perhaps rightfully so) to base generic determinations on any *one* constant character, these preferring to accept a natural assemblage of characters from which to found the genus. A close examination and study of the collections previously referred to revealed in each of the genera (taking the genotype itself or its congeneric representative as a guide) a marked similarity in the form and character of the male genitalia within each genus, so that each of the genera studied could in a very large measure be determined at a glance by the structure of the pygofers and of the exposed genital organs alone, without recourse to other external characters. Within certain genera, as they stand at present, two or more types of genitalia are present and the question arises if such sexual characters, found only in one sex, should be used to erect new genera. In such cases it is highly improbable that the genus is monophylogenetic. In the erection of genera the hind tibial spur or calcar has not been considered as much as it should have been, even by Kirkaldy, Muir and Crawford, who have used it for subfamily and tribal divisions. In discussing the *Liburnia* ("Delphax")

group, Kirkaldy<sup>1</sup> states "the characters which appear to me to be of generic value in this section, lie in the genitalia and the tibial spur, though I am not prepared, without the examination of a large series of European and American forms, to formulate genera based on them." Again referring to genitalia in general, Kirkaldy<sup>2</sup> further suggests "that the genitalia in the male are the final test of a species and even afford generic criteria."

Fieber<sup>3</sup> appears to have been the first to use characters found in the pygofer, anal segment and genital styles for specific purposes and most workers, with a few notable exceptions, have continued their use in certain groups of genera. Edwards<sup>4</sup> appears to have been the first to dissect and figure the aedeagus to distinguish certain allied species. Muir<sup>5</sup> in working out the Hawaiian Delphacidæ, placed greater weight upon the aedeagus and used the male genitalia not only for specific purposes, but also to rearrange the genera. He afterwards found other characters that confirmed his conclusions drawn from the genitalia alone.

In anticipation of using the genitalia in a similar manner Mr. Muir and the author are at present at work upon the North American and West Indian species. In the hopes of interesting students in these organs as characters of systematic importance, the following short description of the methods employed and the terminology decided upon, is presented. Morphologists may disagree with these terms and suggest using others that show the homology with other insects, but until we are sure what those homologies really are it is best to use purely descriptive names, most of which are already in use.

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<sup>1</sup>Kirkaldy, Haw. Sug. Pl. Ass. Report 1907 Div. of Ent. Bull. III, p. 150.

<sup>2</sup>Op. cit. page 124.

<sup>3</sup>Fieber Verhandl. Zool. bot. Ges. XVI, 1866, p. 517-534, Pl. VIII.

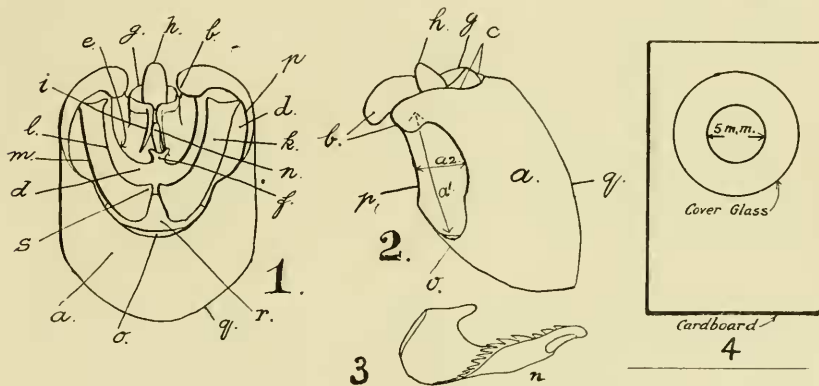
<sup>4</sup>Edwards Hom. British Islands, 1896, pl. 6.

<sup>5</sup>Muir Proc. Haw. Ent. Soc. III, 3, 1916, pp. 221, pls. 2, 3, 4.

## NOMENCLATURE OF GENITALIA.

(See Figures 1, 2 and 3).

What is apparently the ninth abdominal segment in Delphacidae is specialized into a more or less long, chitinous ring (the *pygofer* (*a*)) without any clear trace of tergum, sternum or pleura. The posterior dorsal edge is more or less deeply emarginate (anal emargination (*c*)) and more or less surrounds the anal segment (*g*); the corners of this emargination are more or less angular (anal angle (*b*)) and in some species are considerably produced; the lateral margins (*p*) vary in shape, being straight and entire, produced or excavated; the ventral margin (*o*) also varies in the different species. The relative length and breadth of the opening (*a*<sub>1</sub>, *a*<sub>2</sub>) is also important. The tenth and eleventh abdominal segments form a small tube (the anal segment (*g*)) which lies more or less surrounded by the anal emargination (*c*) of the *pygofer*. The anus opens on this latter segment and below or ventrad of the anus is the anal style (*h*); on the ventral surface of the anal segment are the processes of the anal segment (anal processes (*i*)) generally in the form of a pair of spines. Looking into the opening of the *pygofer* one sees a more or less chitinous wall dividing it into an outer and inner chamber. This is the diaphragm (*d*) the dorsal margin (*e*) of which is generally V-shaped and often in the middle there is developed an armature (*f*); near the ventral



FIGS. 1 and 2.

- a. pygofer; *a*<sup>1</sup>, *a*<sup>2</sup>, opening of pygofer (*a*<sup>1</sup> length, *a*<sup>2</sup> breadth).
- b. anal angle of pygofer.
- c. anal emargination of pygofer.
- d. diaphragm.
- e. margin of diaphragm.
- f. armature of diaphragm.
- g. anal segment.
- h. anal style.
- i. anal process of spine.
- k. genital style.
- l. inner margin of genital style.

- m. outer margin of genital style.
- n. aedeagus (or penis).
- o. ventral margin of pygofer.
- p. lateral margin of pygofer.
- q. base of pygofer.
- r. orifice of diaphragm.
- s. basal angle of genital style.

FIG. 3.

- n. aedeagus.

FIG. 4.

Details of card mount.

*edge or margin (o)* of the pygofer the diaphragm is pierced by an *orifice (r)*, through which the genital styles pass. The length of the diaphragm is from the dorsal margin in the middle to the orifice. In the Delphacidae there is always one pair of *genital styles (k)* which are of various size and shape; the terms *inner (l)* and *outer (m)* margins are of use in descriptive work, also the *basal angle (s)*. The *aedeagus (n)* arises from the bottom of the inner chamber and when at rest its apex generally projects over the middle of the dorsal margin of the diaphragm, just above the armature. There is an internal structure connecting the anal segment to the base of the genital styles, which can be termed the connecting structure.

#### THE DISSECTION AND TREATMENT OF THE PYGOFER AND GENITAL ORGANS.

For ordinary purposes, when comparing the margins of the pygofer and exposed genital organs of a species under examination with any illustration or figure, the binocular microscope is much preferable to the hand lenses ordinarily in use and students should by all means use the former when possible. The size and opaqueness of these organs in very many of the species are such that in careful systematic work even the binocular, without an electric illuminator or condenser,\* is insufficient to secure a proper and correct view of their structure. With an abundance of material to choose from, one might, on occasion, select an example which would result satisfactorily without the illuminator, but otherwise the student is quite apt to draw wrong conclusions.

The structures of the genital organs contained within the aperture of the pygofer are, as previously stated, of the greatest importance for correct determination of the species and these must therefore not only be viewed by the observer under the best of conditions, but on occasion the aedeagus, genital styles and anal tube must be dissected out. The aedeagus itself is so hidden behind the diaphragm of the pygofer that it is seldom visible, even with the strongest of illuminations and magnification. The anal tube, whilst visible, in a measure, with the hand lens or binocular, has in very many instances spines or processes of various lengths attached to its medio ventral surface, which are either quite invisible or are obscured by the genital styles. In many instances specimens, as ordinarily viewed; have their genital styles resting at a different angle than when they are normally at rest, which fact is quite sufficient to alter the outline and lead to error. This can easily be overcome if the styles are dissected out and a flat view taken.

The dissection of the genital organs is simple, if reasonable care is used. The method adopted by Mr. Muir and the author is to carefully sever the pygofer from the abdomen, transferring it to a 50% or 60% solution of Caustic Soda and boiling it over an alcohol flame in an

\* The author has used with much success the B. & L. micr. lamp with aspheric condenser and transformer for 110 V. alternating current. The smaller and cheaper B. & L. illuminator and condenser has not been altogether satisfactory for this special work.

ordinary test tube for a few seconds only. The success of the method depends largely on the boiling process, for if it is boiled too long the clearness of structural detail is spoiled, whilst if it is not boiled enough, much fatty matter will remain attached to the organs to be observed, thereby causing some slight inconvenience in their further dissection and observation. It is, however, far better to underboil than otherwise. The student will soon learn to detect by the size, condition and appearance of the pygofer just what time is required in this boiling process. From the Caustic Soda the specimen is immediately transferred to water in order to wash and clear it. For this, it appears preferable to use a concave glass slide, so that the object may be kept under better control whilst under the binocular microscope. During this clearing process in water, the genital organs should be dissected out from the pygofer. This is done by means of fine needle points, with handles attached, holding the pygofer down with one needle whilst inserting the other through its anterior opening and pushing outwards the organs until all these are plainly visible. If it is intended to make a microscopic slide of the genitalia further manipulation and dissection under the binocular will be necessary in order to free the organs from the diaphragm or wall of the aperture of the pygofer, but for ordinary purposes of identification the pygofer together with the protruding organs can, without further process, be transferred with a very fine camel's hair brush or the point of a needle to the card point on which the insect specimen is mounted. Care must however be taken not to crush or smother the parts during manipulation and the mounting on the card point must also be carefully done, otherwise the organs will appear distorted and useless. Before mounting in balsam it is necessary to transfer the pygofer and genital organs into absolute alcohol in order to dehydrate and harden these. A few minutes only is required and the organs should then be cleared by transferring them from the alcohol to clove or cedar oil. In either one of these latter they may remain for a few hours, if necessary, but if speed is desired, four or five minutes is all that is required.

Some have objections to the microscopic slide process, as the slides have to be kept apart from the cabinet specimens; and again others claim that there is apt to be an absence of detail as shown by the "card point" system. To these may be suggested another and very acceptable method of permanently disposing of their dissections and at the same time keeping these attached to, or alongside, the insect specimen in their cabinets. This system has been called the Balsam card cell process,\* and it has been used to an appreciable extent for the mounting of the genitalia of type specimens. For the purpose, rather stout Bristol board mounts of uniform size should be used (See Figure 4).

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\* Similar cells to these can be used without balsam for mounting delicate types, the insect being fastened with a small drop of clear gum to the bottom cover glass. Dr. David Sharp has types of small Staphalinidae so mounted which can be viewed dorsally and ventrally under a fairly high power. The probability of damage or destruction of such specimens is greatly reduced by using this method.

A cell about 5 mm. in diameter must be smoothly punched towards one end and a 12 mm. circular or square cover glass be gummed or otherwise attached to the underside of the mount and allowed to dry (under cover) for several days before using. A stock of these may be prepared ready for use when necessary. Instead of entirely dissecting out the genital organs from the pygofer, as would be done for making a slide, manipulate and prepare the object as would be done for mounting on card point, taking care, however, that the dissection has later been transferred to alcohol and then into either Xylol or Clove oil before it is finally transferred to the Canada Balsam cell. The transfer from Clove oil or Xylol to the cell (in which a drop of Balsam has been placed) and the manipulation required to secure a proper lateral view of the margin of the pygofer, the armature if any, the anal tube and spines, the genital styles and aedeagus, is a delicate process, but fairly easy after a little experience. Before placing the final cover glass over the object it is well to wait a day or two and be sure that the object has not changed the desired position and that further manipulation is not required. Should a change be necessary, soften the Canada Balsam by passing the mount quickly, for a second or two, over the alcohol flame then using Xylol on needle points to alter the position of the objects. Once assured that the mount is satisfactory, another drop of Canada Balsam to take the final cover glass will end the process and give the student a perfect and permanent specimen of the genital organs. The pin of the insect mount can be run through the end of card cell and so allow the specimen and mount to be placed in the cabinet together. If the card cell sags, a small piece of cork can be glued to the underside of the card cell where the pin pierces it.